

PEDIATRIC INTENSIVE CARE: CONCEPT AND ISSUES

Advances in our understanding of the pathophysiology of complex life threatening processes, pharmacotherapy, and technological capability to monitor and stabilize vital functions have dramatically improved the level of care that can be offered to seriously ill patients. The concepts of intensive care units (ICU) evolved from the efforts to deliver this highly sophisticated and specialized care in an organized manner by a multidisciplinary team approach under one roof. Emergence of subspeciality of Neonatal and Pediatric Intensive Care is a result of the realization that children have distinct physiologic, pharmacologic and psychologic needs, and that these can be met only through ICUs especially designed, equipped and staffed for critically ill children. The subspeciality is still in its developmental phase all over the world. American Board of Pediatrics recognized it as a new subspeciality in 1985, and first accreditation of Pediatric Critical Care training programme was completed in 1990.

Modern Pediatric Intensive Care (PIC) envisages provision of life sustaining therapeutic measures and definitive therapies to children with reversible life threatening conditions, and continuous

monitoring for detection and correction of any abnormality of vital functions, with a goal to achieve reduction in morbidity and mortality. Special Care Units which may be able to provide closer and extended observation of patients, should not be equated with PICUs.

IS PIC Needed ?

PIC is the most important final link in health care delivery to critically ill children. It has brought about a remarkable improvement in survival and quality of life and has uniformly improved the prognosis for critically ill patients with life threatening multisystem failures. PICU survival rates are 80-90% in most of the advanced centres(1) and upto 90% of the survivors are likely to lead an independent life(2). At our centre PICU survival rate was 84% in 1993. As compared to adults, survival and functional recovery are favorable in children receiving intensive care. These children have several years of normal life ahead. These facts should encourage investment of resources in intensive care of critically ill children.

It is essential to have PICUs designed, equipped and staffed to meet the special needs of children. PIC can not be delivered in intensive care units catering to adult patients where children are often viewed as miniadults. Their physiologic and psychologic needs are not adequately attended to. Experience elsewhere has shown that outcome of critically ill children is better in PICUs of tertiary care hospitals than those cared in adult ICUs or local pediatric ICUs(1,3).

Indian Scene

We have witnessed a rapid growth of several well equipped and staffed neonatal intensive care units (NICUs) in our country over the last decade. Establishment of formal training programmes in neonatology and active involvement of National Neonatology Forum in accreditation of neonatal care units has made a beginning towards standardization of the delivery of NIC. The care of critically ill older children has, however, lagged behind in organization. There are only a handful of PICUs in private or government sector. Even these are often managed on an ad-hoc basis by physicians who may not have expertise in the varied aspects of pediatric critical care. Very often the subspecialty back up is also lacking. Some of the important limiting factors in development of PIC are as follows:

High Costs: Intensive care is expensive. We need to calculate expenditure per PICU bed in terms of non-recurring and recurring costs. Neither the government, nor the majority of patients can afford to incur all expenses needed for PIC. Even if a system of health insurance which pays for such medical services is developed, most people will not be able to afford the high premiums. Grants from charities may help off and on. It therefore, becomes necessary to cut down the cost by planning effective utilization of available facilities, developing local low cost technology and equipment and sharing the cost with all those concerned.

Lack of Trained Personnel: Another important issue is inadequate availability of trained manpower in PIC

especially pediatricians and nurses. All pediatricians have interest in care of critically ill children. However, a PICU needs a pediatrician who has an indepth knowledge and understanding of the pediatric subspecialty required for managing multiorgan failure, alongwith skills to perform various procedures, and use life support and monitoring equipment. A definite reduction in mortality rates and improvement in bed utilization efficiency is seen in PICUs with staff especially trained in Pediatric Intensive Care(4).

Lack of Infrastructure: The first link in care of the critically ill, *i.e.*, prehospital stabilization and emergency services and organized referral services are not adequate in most parts of the country. Most of the hospitals, even tertiary care centres, do not have infrastructure to provide PIC. Most of the equipment needed for PIC is imported, the industry is not yet developed enough to prepare sophisticated life saving equipment.

Framework for PIC in India

In India, provision of PIC should be made on a regional basis. To begin with, all large hospitals with tertiary care, and teaching hospitals with 24 hours availability of a pediatrician should have a combined PICU and NICU. A network of strategically located PICUs together with a good referral and transport system can go a long way in improving child survival(5).

It may in fact be desirable to adopt a two-tier approach to PICU, as suggested also by Task Force of CCMS(6,7). Basic PICUs should have the facilities for minimal acceptable monitoring and

therapy required for patients with serious illness of a single system. These units should have transfer arrangement with an advanced PICU, and a well equipped transport team, for those needing complex multiorgan support. Such basic PICUs may be created at secondary referral centres such as district level hospitals.

Advanced level PICU should have capability to provide complex multiorgan support and monitoring, and should receive referrals. They are ideally needed at all tertiary care centres and major teaching hospitals. These units should have continuous availability of sophisticated equipment, specialized nursing, and physicians trained in intensive care. Some beds may be kept for those who have recovered from multiorgan failures or have graduated from ventilator care, but still need continuous infusion of life supporting drugs or intensive monitoring. This concept of intermediate care to low risk, prolonged stay patients may help in cost containment and improve PICU efficiency especially during period of excessive demand. We have this kind of a setup in our unit.

Issues in Setting up PICUs

Assessment of Need: The first consideration in establishing a new PICU is to document the need for such a unit. Otherwise it may be an unnecessary drain on the limited health resources. Since PICU is an integral part of the health care services being offered in a particular set up, an assessment of its need has to be based on the existing patient load and type of illnesses cared for, and availability of broad pediatric subspecialty services.

Design, Lay-out and Staffing: There is very little local experience on designing, and staff requirement^(^). Recommendations made by CCMS(9) and Pediatric Critical Care Society of USA may be consulted for deciding the size, space and lay-out, and other service requirements of PICU to suit local need and resources.

Equipment: Most well established PICUs in the West have multiple sophisticated monitoring and therapeutic equipment. It is neither necessary nor desirable to acquire all these in every newly built PICU. Because of constraint of human and material resources it is advisable to proceed in a phased manner after due consideration to local patient care need, available technical expertise and resources. Obviously, commonly needed equipment such as infusion pumps, vital sign monitors, and ventilation facilities should get preference in the initial stages. This will give time for development of expertise and skills, and allow the most effective use of resources.

Efficient technologic back-up service for highly sophisticated equipment must be ensured from Indian agents selling foreign makes as also the spares for at least 5 years from date of purchase. A somewhat higher price paid at the initial purchase for a equipment which has reliable service and spare backup is any day better than buying a cheaper one with dubious service back-up.

Issues Related to Functioning of PICU

Choice of Therapeutic Modalities: The number of diagnostic, monitoring and therapeutic modalities that are available

for critically ill patients are on increase with newer technology and research. All of these may not be available in a PICU to begin with. A priority list of unique therapies may be drawn depending on the local need, equipment and other resources, and technical expertise, and introduced in a phased manner.

The suggested minimum capabilities required for a PICU are: cardiopulmonary resuscitation, airway management, oxygen delivery systems, emergency cardiac pacing, continuous ECG and CVP monitoring, nutritional support, titrated therapeutic interventions with infusion pumps, and portable life support equipment for transport(11).

Patient Selection and Priority: In India, most of the patients admitted to hospitals are very sick. Sometimes it is difficult to decide which of the several sick patients who require life supporting therapies and uninterrupted monitoring should get the available PICU bed. In view of limited resources and scarcity of available PICU beds, there is a need to define priority. The prioritization should take into account the likely benefit to the patient, the family and the society in terms of long term productivity. Patients with reasonable chance of intact survival should get priority over unstable, critically ill children with remote chance of recovery. Priority should also be given to acutely ill patients with short term PICU need over those requiring prolonged ICU care(12). Prolonged stay patients generally consume much more resources with least benefit(13). Often these decisions require individualized value-judgement. It is best to have the priority criteria and admission and

discharge guidelines clearly written down(12). It is then easier to follow them and may save misunderstanding of colleagues and patients.

Management Policies: For optimal and uniform delivery of services, it is necessary to have clearly written down policies and protocols. These should address management of common medical conditions, various procedures, medications, infection control, nursing care, etc. Written protocols also help resident and nursing staff in training to acquire systematic approach to patient management. The policies and protocol must be reviewed periodically.

Intrahospital Transport: A well equipped mobile transport unit/team should be established for intrahospital transport. Severe complications sometimes occur in critically ill patients during intrahospital transport such as inadequate ventilation, insufficient monitoring, interruption of vasoactive drug infusion, or disconnection and accidental extubation. Transport unit having appropriate portable equipment for monitoring, resuscitation and ventilation have been shown to reduce the unexpected mishaps(14).

Quality Control and Monitoring: Efficient running of PICU requires meticulous record keeping, and data collection for ongoing evaluation, quality control and monitoring. Computerized data collection is desirable. Computer software appropriate to the needs of our PICUs needs to be developed using available resources and guidelines(15). The evaluation and monitoring must address the efficacy of service in terms of patient outcome, resource utilization and cost-effectiveness. Simple system may be evolved or adopted for evalua-

tion of efficacy of therapies, such as therapeutic intervention score(16). Uniform criteria for categorization of different kinds of patients such as PRISM score, may be adopted for internal assessment and quality control over a time period as well as for comparing one PICU with another(17-19).

Parental Participation: We believe parents are an important asset in delivery of PIC in our socio-economic circumstances. In our unit we encourage the presence of atleast one of the parents or a parent surrogate (of course after proper handwash and gowning), with their critically ill child, round the clock. They are valuable observers and of great help in simple nursing chores. Their active participation in care of the child also helps them to understand and cope with the emotional stress. The familiar face and voices of parents is very reassuring to a child who responds to stimuli and greatly accelerates the process of recovery from trauma and stress of procedures and hospitalization.

Professional Relationships: Competition for authority and a hesitancy to relinquish care of one's own patient to another physician are inherent problems during transfer of patients to PICU. Often the problem is because of lack of communication and insufficient resources. The general consensus is that in the interest of efficient care the charge of patients must rest with the PICU consultant. He should have adequate communication with the physician whose patient is in the PICU regarding patient management. Clearly outlined written protocols are also helpful in this context.

Legal and Ethical Issues: Patient management decisions, brain death, withdrawal of life support, organ donation,

and religious beliefs which may interfere with treatment decisions are some of the important issues of PIC.

All management decisions should always be taken as a shared responsibility. Other issues require assessment from the point of benefit to the child, the family and the society, and legality, and a value-judgement be made in consultation with parents(20,21). Launching a child into a life of pain and misery from severe physical or mental disability or prolonging such a life with no hope medically may not make ethical sense to many. An ethics committee comprising physicians, legal experts, social-worker, interested lay persons and others should be formed to take difficult decisions on the above issues.

Future Needs

Strengthening of Prehospital and Emergency Care

The benefit of intensive care can be achieved only if patients are referred and transferred at the earliest before they deteriorate to multiorgan failure or decompensated state, and management is instituted before permanent damage has occurred. The best of intensive care can not reverse the effect of even short periods of cerebral hypoxia. Resuscitation and stabilization of sick children awaiting transfer to PICU must, therefore, take place at the first contact point. Provision of adequate Pediatric Emergency Service manned by staff well trained in emergency care is an essential pre-requisite to successful PIC. Pediatric illnesses that are likely to require complex intensive care may be identified and listed for use of first contact physicians. Patients with these conditions

may be considered for PIC as a matter of routine. A well equipped mobile transport team should be established with each PICU to provide efficient care during transport to PICU.

Guidelines on Design and Staffing

A task force needs to go into the various aspects of designing, staffing and equipping both the levels of PICU and prepare guidelines appropriate to our needs. Design should include location, floor plan, patients, room design, isolation facilities, *etc.* Standards need to be spelled out for gas and oxygen supply, electrical and illumination requirement, and physical environment too. The task force should also define the work and prepare a manual for setting up PICUs. Local experience combined with recommendation made by CCSM(9), Pediatric Critical Care Society of USA(6) and British Pediatric Association(10) may be useful while preparing such guidelines.

Equipment

Equipment required for intensive care is costly and takes away a major chunk of the financial resources. A list of minimum equipment required for different level of PIC with clearly defined specifications should be prepared. An interaction with the Indian Industry to make available low cost locally manufactured equipment is urgently needed. This can help in cutting the cost of setting up new PICUs.

Training

There is definite need for trained physicians, nurses, respiratory therapists, physiotherapists, and other personnel for all levels of care. As a short term strategy in-service training of

physicians and nurses should be arranged. Long-term specific training programmes should be started to meet the future needs. Existing PICUs should participate in training and education of physicians and nursing staff working at secondary and primary levels. These units should run short term courses or training workshops for primary care pediatricians on basic life support, recognition of critical illness, and stabilization and transport of critically ill children.

A postgraduate training program in PIC is certainly needed. There is little or no exposure to PIC in most of pediatric residency programmes across the country or the training period is too short for acquisition of broad range of knowledge and skills necessary to manage a variety of critical care conditions, and organizational, managerial and leadership skills necessary to run a PICU. Curriculum for such a training program needs to be developed(22). Similarly, certificate courses of 6-12 months duration are needed for training of qualified nurses in the patient monitoring, life support techniques, and common PICU procedures, equipment usage, nursing administration, and material management. Trained nurses can facilitate and ease further training.

The concept of nursing aides trained to provide basic nursing care in neonatal and pediatric intensive care may be a reasonable solution to shortage of trained nursing staff. This may also cut down the cost. Formal training programmes may be developed for this purpose.

Research

Ongoing research focussed at

acquiring sound technical knowledge and cost effective ways of delivery and utilization of PIC, appropriate to the needs of our population should be an integral part of functioning of a PICU. There is a need for multidisciplinary basic research to understand mechanisms and therapies for diseases that are dominant killers of our children. Objective evaluation of the benefit of parental participation in PIC is also needed.

Advocacy

The Academy and each of its members have the responsibility to create awareness among policy makers and persuade the Government and leaders of the community for actions aimed at preserving the health of our children. The notion among some that intensive care is unreasonably expensive, often ineffective and a drain on limited health resources needs to be dispelled. The benefit of investing in care of critically ill child needs to be explained logically that the expenses on children is our investment in future of the nation.

The major goals of child survival and healthcare are reduction in infant and child mortality which include reduction of death due to diarrhea and ARI. Use of oral rehydration, standardized case management of pneumonia and immunization and nutrition services should be able to achieve the goal to some extent. However, for a substantial reduction in death rate, appropriate care has to be made available to sickest of the sick children. Deaths from acute respiratory infections occur from respiratory failure, sepsis kills through septic shock, diarrhea is fatal because of severe dehydration or acute renal failure. All of these conditions and others common

killers of our children such as meningitis, tetanus, acute severe asthma, serious poisonings, uncontrolled heart failure, severe trauma, uncontrolled seizures require PIC for successful treatment. Complex illnesses such as hyaline membrane disease, shock, respiratory failure, increased intracranial pressure that were previously fatal are now treatable and many who would have sustained permanent disability now recover completely because of availability of PIC.

Crux of the strategy of Child survival and safe Motherhood Programme launched in 1992 centers around enabling institutional buildup for total care of the most vulnerable pregnant women and children under 5 years by providing most essential and life saving services at an accessible place. The program envisages coverage of all the districts in phased manner. While the budgetary allocation to other components of the program are needed, there is simultaneous and equal need for creating PICUs to deliver life saving services to critically ill children. These will also serve as training facilities to meet the future needs of trained manpower. If critical care needs of adults are being met through adult ICUs, CCUs, CTUs, Intensive Care Renal units and so on, I am sure children who cannot speak for themselves will also see their intensive care needs fulfilled through PICU one day in this country with the world's oldest surviving civilization.

Sunit Singhi,
*Additional Professor,
Department of Pediatrics,
Post Graduate Institute of Medical
Education and Research,
Chandigarh 160 012.*

REFERENCES

1. Pollack MMI, Alexander SR, Clarke N, *et al* Improved outcomes of tertiary centre paediatric intensive care, A state wide comparison of tertiary and non-tertiary care facilities. *Crit Care Med* 1991,19: 150-159.
2. Butt W, Shann F, Tibbals J, *et al* Long term outcome of children after intensive care. *Crit Care Med* 1990, 18: 961-965.
3. Pollack MM, Katz RW, Ruttimann VE, Getson PR. Improving the outcome and efficiency of intensive care: The impact of an intensivist. *Crit Care Med* 1988, 16: 11-17.
4. Yeh TS. Regionalization of paediatric critical care. *Crit Care Clin* 1992, 8: 23-25.
5. Committee on Hospital Care and Pediatric Section of the Society of Critical Care Medicine. Guidelines and levels of care for paediatric intensive care units. *Pediatrics (Indian Edition)* 1993, 5: 450-460.
6. Society of Critical Care Medicine. Task Force on guidelines for categorization of services for critically ill patients. *Crit Care Med* 1991,19: 279-285.
8. Singhi S. Organization of a Paediatric Intensive Care Unit. *In: Principles of Paediatric and Neonatal Emergencies*. Eds. Sachdev HPS, Puri RK, Bagga A, Choudhury P. New Delhi, Jaypee Bros, 1994, pp 354-361.
9. Society of Critical Care Medicine, Task force on guidelines. Recommendations for critical care unit design. *Crit Care Med* 1988,16: 796-806.
10. Paediatric Intensive Care Society. Standards for Paediatric Intensive Care. Hertfordshire, Care of the Critically Ill, 1992.
11. Society of Critical Care Medicine. Task force on guidelines. Recommendations for services and personnels for delivery of care in critical care setting. *Crit Care Med* 1988,16: 809-811.
12. Society of Critical Care Medicine. Task force on guidelines. Recommendations for intensive care unit admission and discharge criteria. *Crit Care Med* 1988,16: 807-808.
13. Pollack MM, Wilkinson JD, Glass NL. Long stay paediatric intensive care unit patients. Outcome and resource utilization. *Pediatrics* 1987, 80: 805.
14. Link J, Kranse H, Wagne W, Papadopoulos G. Intrahospital transfer of critically ill patients. *Crit Care Med* 1990, 18:1427-1429.
15. Dean MJ, Booth FVM. Microcomputers in Critical Care- A Practical Approach. Baltimore, Williams and Wilkins, 1985.
16. Keane AR, Cullen DJ. Therapeutic intervention scoring system update 1988. *Crit Care Med* 1983,11:1-3.
17. Pollack MM, Ruttiman VE, Geston PR. Paediatric risk of mortality (PRISM) Score. *Crit Care Med* 1988, 16: 1110-1116.
18. Pollack MM, Getson PR, Ruttimann VE, *et al*. Efficiency of intensive care. A comparative analysis of eight paediatric intensive care units. *JAMA* 1987, 258: 1481.
19. Coddard JM. Paediatric risk of mortality scoring overestimates severity of illness in children. *Crit Care Med* 1992, 20:1662-1665.
20. Nelson LJ, Nelson RM. Ethics and the provision of futile, harmful, or burdensome treatment to children. *Crit Care Med* 1992, 20: 427-433.
21. Lace JM. Conflict over ethical principles in the intensive care unit. *Crit Care Med* 1992, 20: 313-315.
22. Society of Critical Care Medicine. Task force on guidelines. Recommendations for program content for fellowship training in critical care medicine. *Crit Care Med* 1987,15: 971-977.